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October 29, 1957

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Dear Al:

We are enclosing three copies of Progress Report No. 9 on our Project No. A-100 covering the month of September, 1957.

Expenditures on this project during the month of September amounted to \$2,162.37, leaving an approximate unexpended and uncommitted balance of \$8,598.04.

Sincerely yours,



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C-1331

3 encls.  
RWB/es

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**Project No. A-100**  
**THICKNESS MEASUREMENT OF**  
**NON-METALLIC MATERIALS**

**Progress Report No. 9**

**for**

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**Oct. 29, 1957**

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## THICKNESS MEASUREMENT OF NON-METALLIC MATERIALS

### I. INTRODUCTION

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This is a report of the progress on  Project No. A-100 for the month of September, 1957. The purpose of this project is to develop an ultrasonic method of determining the thickness of non-metallic materials. This determination is possible if the thickness resonances of the sample or the time required for a ultrasonic wave to traverse the sample can be measured.

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### II. PROGRESS

Several new techniques for indicating resonance were investigated during the period of this report. Whenever there is a resonance in the transducer-sample system, there is an increase in the power drawn by the transducer, which is usually indicated as a lowering of the resistance between the two electrical terminals of the transducer. Previously the resonances were detected by observing the variations in the voltage across the transducer as the frequency of the high impedance (constant current) generator driving the crystal was swept through the region containing the suspected resonances.

To increase the sensitivity the transducer was placed in one arm of a bridge circuit. If the bridge is balanced in a frequency region where there are no resonances, where there is a resonance at the frequency of the input signal the inbalance is easily detected.

An even more sensitive method depends on choosing the constants of the oscillator circuit so that, with the crystal as part of the resonating circuit, the increased power drain at the resonance frequency of the transducer or the sample reduces the voltage feedback, stopping the oscillation. Thus, if the oscillator is swept through the required frequency range by means of a variable capacitor in parallel with the capacitance of the transducer, the points of resonance will be shown by the abrupt changes in the plate voltage or current when the oscillator shuts off.

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The third resonance indicator that was investigated was a phase sensitive detector developed by the Electrical Engineering Department of [redacted]. This enables one to measure the magnitude of that part of the current through the transducer which is in phase with the voltage across the transducer. The elimination of the out of phase current, which is due to the transducer characteristics, provides a greater sensitivity.

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Any of the above seems capable of providing sufficient sensitivity for resonance detection. Thus, the problem that confronts us in thickness measurements by the resonance method is not one of detection of resonance, but of the elimination of spurious resonances.

The new barium titanate ceramics which were obtained during the period of this report were larger and, hence, had lower resonant frequencies than the ceramics investigated in the past. Preliminary results showed no great improvement when using these transducers in either the resonance or the pulse-echo method.

Along with the large transducers mentioned above, two barium titanate ceramics in the form of thick-walled cylinders were obtained. These were used, with smaller transducers placed in the center hole, to investigate the possibility of using concentric transducers, one as a sender and one as a receiver, in the pulse-echo method. The results were discouraging, as were the results obtained in an attempt to match the transducer to a concrete sample with a layer of mercury.

However, a new transducer mounting, based on the somewhat successful bakelite holders used with the smaller ceramics, is now being made. This mounting will accommodate both the new solid and hollow cylinders of barium titanate, and it is hoped that this will improve their performance.

### III. FUTURE PLANS

An alternate form of transducer, utilizing the inner volume change of a thin-walled cylinder of barium titanate, will also be tried as a sender or receiver. Otherwise, the work will continue in much the same direction as previously.

#### IV. NOTEBOOKS

The work reported here is recorded in  Notebook No. C-6516.

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#### V. CONTRIBUTING PERSONNEL

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The work reported here has been done by  with the  
assistance and supervision of

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Respectfully submitted,

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APPROVED:

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